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Machine Tools and Metalworking Equipment

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Contents

MACHINEBUILDING INDUSTRY IN UKSSR DISCUSSED

Kiev EKONOMIKA SOVETSKOY UKRAINY in Russian No 7, Jul 81 (signed to press 17 Jul 81) pp 33-35.

[Article by Docent O. Orlov, candidate of economic sciences, Docent Yu. Gokhberg, candidate of economic sciences, and L. Pronchenko, senior scientific taff: "Improvement of Planning Methods for Renovation of Production Equipment at Machinebuilding Plants"]

[Text] Renovation of physical plant is a process entailing simple and large-scale replacement and reduction (elimination) of the detrimental influence of obsolescence and physical wear on production efficiency through capital construction, rehabilitation, expansion of physical plant, replacement of obsolete equipment, modernization, and overhaul.

The present article is a study of problems in improved planning of renovation, particularly for operational facilities. Our research subjects were the gas-equipment plants (GEP) of the Soyuzgazmashapparat All-Union Production Association of the USSR Ministry of the Gas Industry, which are characterized by use of a large amount of obsolete equipment. When expressed as an average for the association, the proportion of machine tools less than ten years old is 53.4 percent and that of forging and pressing equipment of similar age is 49.5 percent. These figures are slightly lower than those for the Soviet machine-building industry. As was noted by A. N. Kosygin in his report to the 25th CPSU Congress, "According to data for recent years the proportion of equipment less than ten years old in the overall inventory has been approximately 57 percent, while that for forging and pressing equipment has been 55 percent."

A great deal of the processing machinery in gas-equipment plants has been in use for more than 10 years. In the case of forging and pressing equipment, this is true of 73.2 percent of that at the Ashkhabad plant, 63.6 percent of that at the Omsk plant, 63.6 percent of that at the L'vov plant, and 44.7 percent of that at the Dnepropetrovsk plant. The corresponding percentages for machine tools are 35, 50, 38.3, and 45.9 percent. In this connection, physical-plant renovation must be speeded up at facilities belonging to the association.

It should be noted that one shortcoming of existing renovation-planning practice is a lack of current information on equipment operation, age, and throughput.

The improvement of plant-renovation planning is closely related to the problem of developing and introducing automated control systems (ASU) and utilizing them as a basis for a standardized multipurpose physical-plant data bank. First-phase ASU have now been installed and are in operation at a number of gas-equipment plants; they will make it possible to employ information from different data bases to accomplish the ends of the second phase. One problem on which work is being done is that of quantitative evaluation of production-equipment efficiency, which should provide the basis for compilation of renovation plans.

Methods for physical-plant renovation are now being devised and put into practice. However, they do not provide preliminary estimates of machine efficiency for the purpose of identifying inefficient, low-productivity technology.

Interplant comparative analysis was employed to work out indicators for such evaluation. Interchangeable production-equipment groups (IPEG) were chosen as the subjects for comparison. They consisted of equipment types with similar characteristics used for manufacture of a given type of product. Equipment-code sector identification numbers reflect the groupings for IPEG. Machine tools and forging and pressing equipment have been grouped into 16 IPEG.

We propose the following indices for analysis of production-equipment efficiency: IPEG throughput and the age of each machine tool in a IPEG. In order to determine the first index, a throughput norm must be established for the d-th IPEG and compared with the corresponding figure for the plant taken as the reference base. The latter should be the plant at which the equipment throughput norm is highest.

In order to ensure comparability for all the products manufactured at the plants, we chose a basic item (the class 1 gas range of type PG2, class 1 "a"). The proportion of the basic product in the total output of the gas-equipment plants is 70-80 percent. Using a statistical method for reducing data to comparable measurement units, the annual output of other products (in terms of labor input) is converted to basic-product terms, i.e., the data are expressed in arbitrary units. The labor input of the product manufactured in the d-th IPEG is corrected for the norm-overfulfillment factor. The throughput norm for the d-th IPEG is determined from the formula:

$$N_d = O_d^f; \quad L_d/K_r$$

$$\frac{\left(O_d^{ba} + \sum_{i=1}^{n} O_{di} \frac{L_{di}}{L_d^{ba}}\right) \cdot K_r}{\sum_{j=1}^{n} tgh \cdot mhj \cdot O_{ij}}$$

where N_d is the throughput norm for the d-th IPEG, O_d^f is the annual output of standard gas ranges for the d-th IPEG, L_d is the labor input for the product manufactured in the d-th IPEG (h), K_r is the norm-overfulfillment factor for the r-th occupation, O_d is the annual output of the basic product manufactured in the d-th IPEG, O_{di} is the annual output of the i-th products manufactured in the d-th IPEG. L_{di} is the labor input for i products manufactured in the d-th IPEG (h), L_d^{ba} is

Table 1. Reserves for Increase in Productivity of IPEG Comprising General-Purpose Lathes and Screw-Cutting Machines with Machining-Surface Diameters of up to 400 mm in 1976

Plant	Annual output of standard gas ranges for d-th IPEG	Adjusted labor input of standard gas ranges manufactured in d-th IPEG, h	Throughput of d-th IPEG, no. (gr. 2/gr. 3)
Ashkhabad	84428	10812	7.81
Brest	207220	18292	11.32
Krasnodar	140244	13904	10.08
L'vov	220108	25312	8.69
Omsk	140132	18444	7.59
Ordzhonikidze	180888	19060	9.49
Fergana	156456	20128	7.76

Plant	Calculated number of standard gas ranges, gr. 4 (index for progresive plant) x gr. 3	Reserves for improvement of equipment, %, (gr.5 - gr. 2)/gr. 2 x 100%
Ashkhabad	122391	44.81
Brest	--	--
Krasnodar	157393	12.32
L'vov	286531	30.41
Omsk	208786	48.15
Ordzhonikidze	215759	19.23
Fergana	227848	45.62

the labor input of the basic product manufactured in the d-th IPEG (h), t_{dh} is the time required for manufacture of the h-th component in the d-th IPEG (h), mhj is the number of h-th components used in the j-th product, and 0_{dj} is the annual output of the j-th products manufactured in the d-th IPEG.

The calculated annual output of standard gas ranges (0_d^c) determined from the maximum equipment throughput for the group of plants being analyzed is calculated from the formula:

$$0_d^c = N_d \cdot \frac{L_d}{K_r} = \frac{N_d}{K_r} \cdot \sum_{i=1}^{n} tgh \cdot mhj \cdot 0_{dj}$$

Raising the throughput of the IPEG to the reference level at the plant under consideration by improvement of the technology used and replacement of outmoded technology makes it possible to increase the output of standard gas ranges ($\Delta 0_d$):

$$\Delta O_d = O_d^c - O_d^a$$

The potential for increased equipment throughput in the d-th IPEG (P_d) is determined from the formula:

$$P_d = \frac{\Delta O_d}{O_d^a} \cdot 100\%$$

In cases where there is a substantial potential for increasing the throughput of interchangeable production-equipment groups, the mere existence of this potential indicates that older, low-productivity equipment is being used in the groups in question and that this equipment must be replaced first. Our analysis established that a progressive throughput level has been achieved for the IPEG comprising "general-purpose screw-cutting lathes with a machining-surface diameter of up to 400 mm" at the Brest plant, where the throughput of this group equals 11.5 standard gas ranges (see Table 1). Throughput level is lower and a significant potential for increasing it exists at plants such as those in Omsk and Ashkhabad. Large numbers of the lathes in use at these plants (62.5 and 49.4% respectively) are more than ten years old.

Similar data were obtained for other IPEG in our study. For example, the highest throughput for the IPEG composed of "upright drilling machines producing holes with a diameter of more than 12 mm" was found to have been achieved at the Fergana plant (15.16 standard gas ranges). The potential reserves for increasing the throughput of such equipment amount to 35.13 percent at the L'vov plant, 34.51 percent at the Omsk plant, and 22.72 percent at the Ashkhabad plant. There is similarly a considerable potential for increasing the throughput of the IPEG stipulated to consist of "presses generating forces of from 105 to 205 tons"; the potential throughput reserve for this group amounts to 53.26 percent at the Omsk plant, 49.84 percent at the L'vov plant, and 10.08 percent at the Krasnodar plant. The significant potential for enhancement of throughput at the Omsk plant can be attributed to the inclusion of a large amount of obsolete equipment with low productivity. Thus, of the nine machine tools presently on line, only one has been in use for less than ten years. The service time of the remaining machines ranges from 15 to 21 years.

It should be noted that, when the proportion of equipment less than ten years old is large (as is the case for the plants at Brest and Ordzhonikidze), IPEG throughput is high and the rate of increase in labor productivity has outstripped the rate of increase in capital investments. Where the proportion of obsolete equipment is large (as is the case for the plants at Omsk, L'vov, and Krasnodar), the IPEG have lower throughput, the rate of increase in capital investments has outstripped the rate of increase in labor productivity, and capital productivity has decreased.

The age of each machine tool in an interchangeable group is the next index for quantitative evaluation of production-equipment efficiency. It is a subsidiary index and, on the basis of our earlier analysis, enables us to identify the physically worn equipment in each group. For this purpose, it is necessary in analyzing the d-th interchangeable group to calculate for each machine tool the difference between the actual machine service life (B_a^z) and the rated service life (B_r^z) from the formula:

$$\Delta B_d^z = B_a^z - B_r^z$$

For each piece of equipment in the interchangeable group, we must then determine the age factor (K_a^z), which is the ratio of its actual service life to its rated life. The age factor rises from 0 to 1 as the machine-tool service life increases. If $K_a^z \geq 1$, this indicates that the rated service life of the machine tool has expired and its further use is inexpedient; it should be replaced with a more modern model.

Methodological suggestions based on the results of this research have been made to leading gas-equipment plants for use in compiling plans for replacement of obsolete equipment. Employment of the proposed method for identification of equipment with low throughput that does not meet current requirements and planned removal of such equipment from service will lead to "rejuvenation" of the machine inventory and modernization of its structure. The calculations that have been made show that planning of obsolete-equipment replacement by this technique will allow us, over the next two or three years, to reduce the proportion of obsolete equipment and increase machine throughput by 15-25% (at the Omsk, L'vov, Krasnodar, and other plants).

The data given above thus emphasize the need for improvement of planning for obsolete-equipment replacement.

Under the conditions of ASU, replacement planning can be broken down into the following series of interrelated steps:

a) combining of equipment into technologically interchangeable groups, assignment of codes, and compilation of a plant equipment-code index;
b) preparations for analysis of equipment inventory;
c) quantitative evaluation of production-equipment efficiency;
d) compilation of a card index of equipment suffering from physical wear;
e) compilation of a card index of obsolete equipment;
f) selection of standard models for each IPEG;
g) calculation of the effectiveness of replacing obsolete and worn equipment;
h) determination of the equipment required as replacements;
i) compilation of a program for replacement of worn and obsolete equipment;

Our proposed method can be used for interplant comparative analysis within a production association, permitting identification of low-productivity obsolete and worn equipment and planning of measures directed at improving production technology.

The method in question can also be employed at other plants.

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IMPROVING CALCULATION OF PRODUCTION CAPACITY FOR MACHINEBUILDING PLANTS

Kiev EKONOMIKA SOVETSKOY UKRAINY in Russian No 7, Jul 81 (signed to press 17 Jul 81) pp 39-43

[Article by O. Smolyakova and N. Lepa]

[Text] At the present stage of Soviet economic development, we are turning toward intensification, with emphasis on more complete use of available production capacity and reduction of the time needed for bringing new capacity on line. The achievement of these ends requires improvement of organization, management, and production planning methods. It is necessary to improve determination of plant production capacity and the selection of criteria, indices, and measurement units. Greater attention must be paid to maximum utilization of machinery and attendant enhancement of output without additional capital investment.

The production capacity of an enterprise must be related to its technical-economic characteristics. The technical level of production characterizes the degree of production-facility expansion, particularly that of physical plant. The production capacity of an enterprise (sector) is a basic component of the data used for formulating a plant (sector) production program. Production capacity determines potential output capability. Since it represents an ideal version of the production program, it will always exceed the actual production plan for the period covered.

There is no unambiguous definition in the literature for the concept of production capacity. In practice, plant capacity is presently measured in real production units and expressed in terms of value, making it comparable to the actual output and production plan.

Production capacity depends on the following factors: the product list and range, the makeup of the basic production facilities, the labor input in manufacture of the finished product, and the skill of the workers, as evaluated form the percentage fulfillment of production quotas.

The level of production-capacity utilization is determined by: the calculated (actual) output of products covered by the production program, the labor supply, the average percentage of output quota fulfillment by the workers, the organization of production and labor (the actual equipment operating time), the organization of logistics support, and the provision of ancillary services (regular maintenance, etc.).

We feel that, in calculating production capacity by existing methods, the dependence of this parameter on the nominal product list is one of the major shortcomings in its determination. Capacity calculated on a reference date for different product lists has different values. When the workforce is constant, the production capacity will vary with the product list. This relationship will be maintained regardless of the capacity-measurement units used (natural, value-based, or adjusted).

The capacity of a plant can be written in the following general form:

$$M = \sum_{j=1}^{n} (H_j \times K_i) \times \frac{1}{100}, \tag{1}$$

where M is the plant capacity in natural or value-based units, K_i is the production capability of the i-th machine group limiting the output of the j-th product (percent), H_j is the output of product j called for by the plan (report) in natural or value-based units, and n is the number of product types specified by the plan (report).

The capacity of an enterprise can be determined only by proceeding from a specific product and the individual equipment groups involved in the basic production process. The actual annual operating time for the machine groups serves as the basis for calculating capacity but has no independent significance.

Design capacity for the product list cannot always provide the basis of the production plan for an enterprise (sector), since the nominal product list may not correspond to the product range produced even while the planned capacity is being brought on line. Machine-building plants have multiproduct programs, with the labor input of the products produced changing annually and some products being replaced by improved versions. Scientific and technical innovations accelerate this process. Each enterprise therefore performs considerable work each year in calculating production capacity.

At an operating enterprise, the capacity in terms of the planned product list does not produce uniform workloads for all machine groups; production capabiliy varies over a very wide range and we can consequently speak of maximum equipment utilization only when equipment technological structure wholly corresponds to the labor-input structure of the product to be manufactured. The disproportions in equipment workloads are substantial at all enterprises. Indicative in this respect is calculation of the extent to which equipment structure corresponds to processing structure for steel-shape production at a coal-machinery plant, the results of which are given in Table 1.

The labor input of the lathe work involved in production of support beams and mechanized systems account for from 54.9 to 74.5 percent of total labor costs for machining. They amounted to 65.5% of total labor costs in the production plan (with the volume of each product taken into account). If we assume the entire lathe group to have a production capability of 100% (the lathes being fully utilized with two-shift operation), the drill group is underutilized (its production capability is 141 percent), the borer group is overutilized (since its production capability is 57.5

percent), the grinder group is underutilized (620%), the gear-machining group is also underutilized (236%), and the milling-machine group is overutilized (72%).

The borer and milling-machine groups become bottlenecks if we consider the lathe group to set the pace (govern the capacity). Since the production capability of the milling-machine group is high, the limiting group is still the borers, which should, in conformity with current methods, be used to determine plant capacity. In this case, the utilization of the lathe group is only 72 percent. The labor input of boring operations accounts for 4.9 percent of total labor costs (compared with 65.5 percent for lathing operations). Unfortunately, capacity calculations carried out as part of annual planning provide for such underutilization at all coal-machinery plants and it has no effect on the plant-capacity utilization factor, since the unused machine time is not included in plant capacity.

Here we are intentionally disregarding the question of measures for elimination of bottlenecks provided for by the capacity-calculation method, which reduce to some decrease in the labor input of machining as a result of adoption of industrial-engineering practices or changeover to three-shift operation for the limiting machine group. Analyzing these calculations for the capacity of coal-equipment plants, we can conclude that elimination of bottlenecks can be brought about by operating the hypothetically limiting machine group on a three-shift schedule (if there are no major changes in the product list between the reference year and the year for which a plan is being compiled) and the labor input of operations at the bottleneck includes the labor costs for other equipment with greater potential capacity. Artificially generated bottlenecks resulting from reallocation of labor input to groups made up by the plant itself (with as few as one or two machine tools) thus cause underestimation of plant capacity. The limiting capacity of a machine group in a coal-equipment plant accounts for only a small percentage of the total for the plant's entire equipment inventory.

It is possible to predict disproportions in equipment utilization before the production plan is drawn up and the capacity calculated, by analyzing the appropriateness of machine-inventory structure, with duty factor and product labor input taken into account. However, we can only speak of full equipment utilization if we calculate the design capacity of the equipment required from the machining labor input.

Considering the production capacity of an operational plant as the maximum output of a given product range under ideal manufacturing conditions and expressing it in natural or value-based units, we cannot speak of full utilization of all the equipment involved in the basic production process unless we give consideration to the product list whose machining-technology structure completely conforms to the equipment-inventory structure.

The presence of unneeded machine tools, i.e., tools that are underutilized on the basis of production-capacity calculations, currently has no effect whatsoever on utilization indices. Calculated production capacity, like capacity actually attained, equals the potential capacity only for that portion of the equipment whose throughput is equivalent to that of the limiting group. The remainder of the equipment used in the capacity calculations but having a throughput greater than the assumed plant capacity (in percent of the planned level) can be divided into: that

Table 1. Calculation of Correspondence Between Technological Structure for Machining of Shapes and Equipment Structure in Major Shops at Machine-Building Plant (Percent of Total)

	Structure of basic equipment	Process labor-input structure			
		Per unit component, support, by types			Program
		MK 97 model I	MK 97 model II	KGU	
Turning - total	55,8	70,9	74,5	54,9	65,5
including					
CH of 200 mm	24,2	29,2	34,7	30,9	
CH of 300 mm	14,0	24,1	24,2	9,8	
CH of 500 mm	1,3	3,2	2,9	1,3	
Drilling - total	12,6	9,2	6,8	10,0	10,5
including					
vertical	6,1	3,3	1,3	0,5	
radial	6,5	5,8	5,5	9,5	
Boring	2,4	4,8	4,2	7,9	4,9
Grinding	17,4	3,4	3,4	2,1	3,3
Gear-machining	1,0				0,5
Milling - total	7,8	7,9	7,7	24,0	12,7
including					
vertical	3,4	2,8	3,0	9,4	
Planing	0,3				0,2
Broaching	0,3				0,01

intended for operation in accordance with the plan or capacity calculation (expressed as a percentage of the assumed capacity) and that to remain idle in accordance with the plan or capacity calculation (proportional to the percentage by which the the assumed capacity or plan is exceeded at the plant).

The capacity of a machine-building enterprise can be written as:

$$M = \sum_{i=1}^{m} (N_i \times D_i), \tag{2}$$

where M is the production capacity of the plant in machine-hours, N_i is the number of machines in the i-th group involved in the basic production process, m is the number of equipment groups, and D_i is the actual annual operating time for a piece of equipment with the proportion of daily operation taken into account (h).

The capacity utilization factor for the period covered is calculated with the product of the labor costs for product manufacture taken into account:

$$K_c = T : M, \tag{3}$$

where K_c is the capacity utilization factor and T is the labor input of machining under the program (machine-hours).

The proposed procedure for determination of capacity permits mechanization of calculations and provides the basis for multivariant planning of production programs both for the entire sector and for individual plants.

If we know the calculated or actual capacity of an enterprise and the product demand expressed in natural measurement units, we should be able to compare them not only on the basis of labor costs but also in terms of physical volume. For this purpose, we will use the term "full-capacity output." It to some extent corresponds in magnitude and sense to "production capacity" in the existing method for calculation of capacity. Full-capacity output is the ideal output of a given product list and range with maximum utilization of production capacity. It is not identical to the actual production plan, since it does not take into account the available pool of machine operators, forsee shortages of equipment for individual machine groups, or take into account wastage due to nonideal manufacturing condipions.

Let us examine an example. A plan has a capacity of 11,600 machine-hours. The labor input of machining under the production plan is 5800 thousand machine-hours and the capacity utilization factor (K_c) is 0.5 (5800/11,600 = 0.5). The full-capacity output is calculated at 8600 thousand rubles, the production plan is 8200 thousand rubles, and the planned full-capacity output utilization factor (K_o) is 0.95 (8200/8600 = 0.95). With capacity utilization at 50%, the plant makes use of 95% of its output capability for a given product range. We are forced to conclude that the plant is inadequately specialized and the equipment underutilized. When all the plant's reserves are used and the plan is solidly grounded on capacity calculations (and not "on output achieved," as in the present system), we then have $K_c = K_m$. Bringing the utilization factor for full-capacity output closer to the capacity utilization factor means obtaining performance in the form of finished product from each machine tool installed in the main production facility. This problem should be attacked from two directions. First of all, it is necessary to carry out multivariant planning of the production program in order to increase output and obtain full utilization of equipment and space, at least to the extent permitted by economic demand. Secondly, the structure of the equipment inventory (type makeup and numbers) must be systematically brought into line with the manufacturing labor-cost structure at each plant.

Calculation of capacity requires a list of the equipment involved in the basic production process, with a breakdown by groups (standard for the manufacture of coal-mining machinery) and allowance for changes during the period covered; it is also necessary to know the actual annual operating time for the equipment in each group, using a standard duty factor for all plants in the industry.

The algorithm for calculation of plant production capacity itself includes several direct calculation steps enabling us to: obtain a figure for production capacity, analyze equipment structure, analyze machining labor costs for each product and for the entire program, identify the key equipment group, and determine the capacity utilization factor.

Plant production capacity equals:

$$M = M' + M'' + M''', \tag{4}$$

where M' is the capacity of the equipment in place and operational over the entire period covered (machine-hours), M'' is the capacity of equipment removed during the period covered (machine-hours), and M''' is the capacity of equipment added during the period covered (machine-hours).

The capacity of the equipment operating over the entire period is determined from the formula:

$$M' = \sum_{i=1}^{m} N'_i \times D_i, \tag{4.1}$$

where N'_i is the number of pieces of equipment in the i-th group operating over the entire period and D_i is the operating time for one machine tool in the i-th equipment group.

The capacity of the equipment removed is determined from its working time prior to removal:

$$M'' = \sum_{i=1}^{m} \left[\sum_{\sigma=1}^{N_i} N_{i\sigma} \times (R_{i\sigma} - 1)\right] \times \frac{D_i}{12}, \tag{4.2}$$

where $N'_{t\sigma}$ is the number of pieces of equipment removed from the i-th group during the period covered and $R'_{t\sigma}$ is the number of months for which this equipment operated during the period covered before being removed.

The capacity of the equipment added is determined from its operating time, starting with the month that it was brought on line:

$$M''' = \sum_{i=1}^{m} \left[\sum_{\xi=1}^{\tau} N_{i\xi} \times (12 - R_{i\xi})\right] \times \frac{D_i}{12}, \tag{4.3}$$

where $N_{t\xi}$ is the number of pieces of equipment added to the the i-th group during the period covered, $R_{t\xi}$ is the number of months for which this equipment operated during the period covered (starting with the month when it was brought on line), and τ is the total number of equipment groups added during the period.

In the second stage, we determine the equipment-capacity structure over all groups as the ratio of the capacity of each equipment group (M_i) to the total plant capacity:

$$S_i = M_i : \left[\sum_{i=1}^{m} M_i\right] \tag{5}$$

In the third stage, we calculate the labor-cost structure for each product (F_{ij})

and determine the key equipment group for this product (F_{kj}):

$$F_{ij} = t_{ij} : \left[\sum_{i=1}^{m} t_{ij} \right], \tag{6}$$

where t_{ij} is the labor input for machining of the j-th product in the i-th equipment group (taking into account the average percentage operator-quota fulfillment by occupation).

The key equipment group for j-th product output is determined from the maximum labor costs for the i-th equipment group:

$$F_K = \max_i F_{ij}.$$

In the fourth stage, we determine the labor-cost structure for the program ($\overline{F_{ij}}$) and the key equipment group ($\overline{F_k}$):

$$(\overline{F_{ij}} =) \frac{t_{ij} \times n_j}{\sum_{j=1}^{n} \sum_{i=1}^{m} t_{ij} \times n_j}, \tag{7}$$

where n_j is the output of the j-th product in the program.

The key equipment group for the plant is determined from the maximum labor costs under the program:

$$(\overline{F_K}) = \max_i (\overline{F_{ij}}).$$

The final step in solving the problem is determination of the capacity utilization factor for each equipment group and for the entire plant, i.e., (K_i) and (K):

$$(\overline{K_i}) = \frac{\sum_{j=1}^{n} t_{ij} \times n_j}{M_i}, \tag{8}$$

$$(\overline{K}) = \frac{\sum_{j=1}^{n} \sum_{i=1}^{m} t_{ij} \times n_j}{M}. \tag{9}$$

The optimum production plan is the full-capacity output of a given product list and range, with the constraints imposed by economic demand and maximum utilization of key-group capacity (for which $K_c = 1$). The other groups may be underutilized (capacity reserve) or overutilized (capacity shortage), deviations that must be minimized. The shortage or excess of machine tools is determined in this case.

The problem can be formulated mathematically in the following manner: minimization of the deviations in equipment-type structure from labor-cost structure in the program:

$$(S_i - F_{ij}) \to \min \tag{10.1}$$

with the following conditions:

approximation of labor costs in the program to the capacity for each equipment group:

$$\sum_{j=1}^{n} t_{ij} \times X_j + \lambda_i - \delta_i = M_i, \tag{10.2}$$

determination of full-capacity output within the framework of the output achieved and future output quotas (the demand for a given type of product):

$$\underline{X_i} \leqslant X_j \leqslant \overline{X_j}, \tag{10.3}$$

with positive solutions

$$X_j \geqslant 0. \tag{10.4}$$

Correspondence between the labor input for the key equipment group and the capacity of this group

$$\sum_{j=1}^{n} t_{Kj} \times X_j = M_K, \tag{10.5}$$

where X_f is the optimum-plan vector ($j = \overline{1,n}$), λ_i is the equipment "underutilization" vector ($i = \overline{1,m}$), δ_i is the equipment "overutilization" vector ($i = \overline{1,m}$), $\underline{X}_j$ is the minimum permissible production plan (the actual output product output in the previous year), $\overline{X}_j$ is the maximum permissible production plan (set by the prospective plan or demand), t_{kj} is the labor costs of each j-th product for the key equipment group, and M_k is the capacity of the key equipment group.

Equation (10.2) defines the maximum equipment utilization, i.e., full equipment loading. Here $\lambda_i \neq 0$ when $\delta_i \neq 0$ and vice versa. When the i-th equipment group is underutilized, the degree of overutilization automatically equals zero.

Solution of the problem yields the full-capacity output, which equals the optimum production plan (X_j), and the equipment underutilization (λ_i) and overutilization (δ_i) vectors. The latter parameters are employed to determine the equipment deficiencies and surpluses for full-capacity output.

The actual production plan adopted each year by a plant (sector) should take into account the available labor force and the volumes of basic and subsidiary production (giving consideration to equipment and attachment repair and the fabrication of tools and attachments at service shops and under cooperative agreements). If the plan must be adjusted or changes made in the cooperative programs during the period covered, corrections are made in the data base and the calculations repeated.

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IMPROVING SPECIALIZATION OF TOOL PRODUCTION

Kiev EKONOMIKA SOVETSKOY UKRAINY in Russian No 7, Jul 81 (signed to press 17 Jul 81) pp 44-51.

[Article by B. Kryzhanovskiy, candidate of economic sciences]

[Text] Accelerated growth of machine building and metal-working, improvement of labor productivity, and enhancement of the efficacy of capital investment, equipment throughput, and the efficiency of equipment utilization all in large part depend on equipping manufacturing processes with tools and attachments and on the overall status of tool production. In recent years, favorable results have been achieved in raising the technical level and quality of the tools produced, chiefly through use of new durable and high-performance high-speed steels and hard alloys.

The Ukraine is a major producer of tools and attachments. However, in spite of substantial progress, tool production in the republic still has available substantial unused capacity and untapped resources. The most significant of these are further intensification of specialization and substantial expansion of work on unification, standardization, and normalization of tools and machine-tool attachments. Thus, according to research data, almost a third of the aggregate increase in labor productivity in machine building can be considered to result from measures taken to improve production specialization. Calculations likewise confirm the great effectiveness of efforts to intensify specialization of tool production, mostly industrial-engineering measures directed at increasing the output of metal-working tools and machine-tool attachments, improving their quality, and lowering their manufacturing costs.

Comprehensive evaluation of the level of tool-production specialization utilizes a system of indicators, of which the most important are: the specialization coefficient, i.e. the proportion of tools and attachments manufactured by specialized tool-industry plants in total output expressed in terms of value; the portion of tool demand satisfied by internal production; the proportion of tools and attachments supplied by tool plants in meeting total tool demand; the number of plants and shops producing the same classes, groups, and types of tools; the lot size of the tool types manufactured.

The basic indicators of tool-production specialization in the Ukrainian machine-building industry are shown in Table 1.

As is evident from the data in this table, production of tools and attachments at specialized plants increased by a factor of more than 1.9 over the period 1970-1979 (from 61.3 million rubles in 1970 to 119 million rubles in 1979). However, the rate of increase in production at these plants barely exceeded the corresponding growth rate for machine-building-plant tool shops. The coefficient of demand satisfaction for the period was therefore very low. As usual, almost two-thirds of the tools and attachments produced were from tool shops and only 38% from tool plants under the jurisdiction of the USSR Ministry of the Machine-Tool Industry.

The situation that has arisen in production and demand satisfaction for tools and attachments in the Ukrainian machine-building industry is, on the whole, not adequately rational. This is obvious from a comparison of basic technical-economic production indicators at tool shops and in specialized tool plants. Calculations show that labor productivity, capital efficiency, production yield per square meter, and production output per machine tool at a tool plant average 2-3 times the figures for tool shops. This is explained by the well-known advantages of specialized production.

Specifically, the advantages of standardization and unification of machine-attachment design can be fully exploited in specialized tool plants. Broad standardization of components and unification of design allow organization on serial-production principles, in many cases even for filling of individual orders.

Large scale manufacture of uniform products makes the use of specialized high-performance equipment cost-effective. In turn, utilization of special machine tools, electrophysical and electrochemical machining methods, progressive new production techniques, and mechanization of manual labor considerably reduce the labor input of tool and attachment manufacture.

As studies have shown, current specialization of production at tool plants in the Ukraine is on the whole, quite rational. The lot size for cutting tools manufactured at these plants is such as to permit utilization not only of highly specialized high-perfomance equipment and group technology, but also in some cases of automated production lines. For example, in 1979, the Vinnitsa tool plant produced more than 210 thousand multiflute drills, over 6.8 million reamers, and almost 8 million milling cutters. At the Boykov tool plant in Zaporozh'ye, production exceeded 6 million taps, 8.1 million milling cutters, and 7 million single-point tools. The L'vov tool plant, specializing in the manufacture of taps, thread-cutting dies, and milling cutters, likewise produced them in volumes large enough for highly effective utilization of appropriate special equipment (9.2 million taps, 8.1 million thread-cutting dies, and 2.3 million milling cutters).

The advantages of standardized production at tool plants are obvious, since the optimum technical-economic indicators (compared with tool shops and current list

Table 1

Calculation of Tool-Production Specialization Indices for UkSSR Machine-Building Industry*

Index	Measurement units	Year						
		1970	1971	1972	1973	1974	1975	1979
Total tool and attachment output	Mill. rubles	176.8	189.2	204.4	217.7	236.5	254.6	315.7
Tool and attachment production by specialized plants .	" "	61.3	68.0	73.5	79.7	83.7	93.0	119.0
Coverage factor	%	34.7	35.9	36.0	36.6	35.4	36.5	37.7
Tool demand	Mill. rubles	134.3	141.1	152.6	160.7	178.5	189.2	234.6
Tool and attachment production by tool shops	" "	115.5	121.2	130.9	138.0	152.8	161.6	198.7
Tool demand satisfied by production in tool shops ...	%	86.0	85.9	85.8	85.9	85.6	85.4	84.7
Centralized tool delivery ...	Mill. rubles	18.8	19.9	21.7	25.7	25.7	27.6	35.9
Portion of total tool and attachment demand satisfied by tool plants	%	14.0	14.1	14.2	14.1	14.4	14.6	15.3

*Compiled from results of investigation conducted by UkSSR Council for Study of Productive Forces (Academy of Sciences of the UkSSR).

prices) make production costs per unit for a particular type and size of cutting tool comparatively low. Calculations have shown that the mean production costs in 1979 for the group of tool plants analyzed were 0.55 rubles for a tap, 0.27 rubles for a thread-cutting die, 1.28 ruble for a reamer, 1.15 ruble for a milling cutter, and 0.85 ruble for a single-point tool. By way of comparison, it might be pointed out that the manufacturing costs for these tool types at the tool shops of plants managed by the USSR Ministry of Tractor and Agricultural Machine Building and located in the Ukraine were 1.24, 2.36, 3.59, 3.41, and 1.38 rubles respectively, i.e., greater by a factor of 3-4 than at tool plants.

This again confirms the satisfactory effectiveness of organizing the manufacture of the most common types of cutting tools on a mass-production basis. It must also be pointed out that specialized Soviet tool plants, including those located in the Ukraine, still do not produce a wide variety of tools. For example, state and industry standards specify manufacture of 1730 types of single-point tools, but tool-industry plants in the Ukraine produce only 270 of them, or 15%; only 207 (24%) of a specified 907 reamers, 167 of 710 (23.6%) multiflute drills and countersinks, 1300 of 3072 (42%) drills, and 700 of 1524 milling cutters are manufactured (D. I. Polyakov and A. I. Kostin, Spetsializatsiya v mashinostroyenii [Specialization in Machine Building], Moscow, Mashinostroyeniye, 1975). Specialized plants do not even produce class AA precision worm-gear hobs, which are stipulated-precision tools for automatic production lines and assembly machines and are widely utilized in mass production and large-scale serial production.

All tool plants in the UkSSR have a structure that includes an entire complex of blanking, service, maintenance, machine, and assembly shops and departments. The service shops and departments of a number of plants occupy rather substantial areas. Thus, their area is 18.9% of the total at the Khar'kov tool plant, 8.7% at the Zaporozh'ye tool plant, 16% at the L'vov tool plant, 13.9% at the Vinnintsa tool plant, 19.9% at the Chernigov Plant for Special Cutting Tools, 23.3% at the Kamenets-Podol'skiy Carbide-Alloy Tool Plant, etc.

Analysis of the operation of specialized tool plants shows that the level of specialization, calculated as the specialization coefficient, is sufficiently high. Manufacture of tools and machine-tool attachments accounts for the majority of production (more than 85% at most plants). At the same time, the specialization coefficient was slightly depressed both in the industry as a whole and for some key enterprises in recent years. This negative trend must be eliminated during the current five-year plan.

As was pointed out above, the specialized tool industry presently satisfies less than 15% of tool demand for the Ukrainian machine-building industry. It meets less than 50% of demand for standard metal-working tools and 3-5% of that for processing attachments; special tools are not manufactured at all.

Tool shops are the main manufacturing base for production of tools and machine-tool attachments in machine building. If we compare their throughput with that of specialized tool plants, it can be seen that they are more productive. Thus, tool shops have available four times the number of machine tools, 6.12 times the pro-

Table 2

Technical-Economic Indices of Tool Production by UkSSR Machine-Building Industry*

Ministry	Growth rate for 1971-1979 (%)		Number of workers	Capital Productivity (rubles)		Labor Productivity (thousand rubles)		Fixed capital (thousand rubles)	
	Product value	Fixed capital		1970	1979	1970	1979	1970	1979
Heavy, Transport Machine Building ..	121.4	173.6	84.4	1.14	0.80	3.23	4.66	2.84	5.83
Power Machine Building	-	-	-	-	1.27	-	5.33	-	4.19
Automotive Industry	165.2	233.0	117.0	1.42	1.00	3.87	5.45	2.73	5.42
Tractor, Agricultural Machine Building ..	182.5	278.4	115.0	1.33	0.87	3.92	6.22	2.96	7.14
Machine Building for Animal Husbandry, Fodder Production	278.9	393.8	237.0	-	0.84	-	4.82	-	5.73
Chemical, Petroleum Machine Building ..	165.2	210.7	128.6	1.11	0.88	4.08	5.25	3.67	5.97
Machine Tool and Tool Building Industry	140.2	208.7	125.5	0.89	0.60	2.89	3.21	3.24	5.40
Instrument Making, Automation Equipment, Control Systems	173.3	262.7	144.9	1.82	1.20	3.26	3.86	1.79	3.22
Electrical Equipment Industry	173.1	213.4	129.5	1.07	0.87	2.93	3.90	2.73	4.48
Construction, Road, Municipal Machine Building ..	145.9	180.5	86.2	0.96	0.78	2.70	4.60	2.81	5.88
Machine Building for Light and Food Industry, Household Appliances ...	176.6	201.0	122.0	0.95	0.83	2.61	3.76	2.74	3.14
Overall for eleven Ministries	164.6	225.3	110.3	1.20	0.87	3.37	4.90	2.82	5.12

*Compiled from data furnished by industry planning institutes and results of investigations by UkSSR Council for Study of Productive Forces (UkSSR Academy of Sciences). Growth rates for Ministry of Machine Building for Animal Husbandry and Fodder Production cover 1973-1979.

duction area, 3175 times the basic capital and almost 5 times the number of operators available to specialized plants of the tool industry. Some sectors of the machine-building industry are superior in terms of numbers of machine tools and operational tool shops. The workforce in the tool shops of machine-building plants is more than double that employed by the plants managed by the Ministry of Machine Building for Animal Husbandry and Fodder Production (48.5 and 21.1 thousand respectively) and approaches that in machine-building plants operated by the construction, highway, and public-works sectors. Tool shops exceed all machine-building facilities in the Ukraine except the automobile industry in terms of number of machine tools on line. Almost as many machine tools are concentrated in the tool shops of Ukrainian machine-building plants as in instrument manufacture, chemical and petroleum machine building, and machine building for light industry, the food industry, and household appliance manufacture taken together. The basic technical-economic indices for the expansion of tool production in the Ukrainian machine-building industry are shown in Table 2.

The aforementioned capacity ratio for tool shops and tool plants lowers the efficiency of tool production as a whole. The multiple-product manufacturing carried out by tool shops determines the character of the production processes and equipment utilized. Analysis of equipment-inventory structure shows that nonprogressive machine-tool models (lathes, cutters, shapers) predominate in these shops; the proportion of turret lathes and special tool-grinding machines for finishing cutting tools is negligible and there are almost no special or automatic machine tools and no transfer machines.

Cases are encountered where small tool shops with low output that carry out a large variety of operations make very little use of even the small amount of progressive equipment included in their inventory. For example, surveys made by a committee of the USSR Ministry of Machine Building for Light and Food Industry and Household Appliances for a group of tool shops at machine-building plants in Kiev, Vinnintsa, and Poltava Oblasts showed that such equipment as model KT16 semiautomatic multitool lathes, model IB61A center lathes, model 7A540 horizontal internal broaching machines, model 5P23BP gear cutters, model 2062 nut cutters, etc. are used for only 3-4 hours out of every 24, while model 4723 electric-pulse duplicating broachers, model 5107 semiautomatic gear shapers, model ZT161 semiautomatic face-milling machines, model 6M12P knee-type milling machines, and model 6A463 duplicating milling machines for the most part operate only occasionally and stand idle a large part of the time.

An excessively large tool product list complicates the manufacturing process, impedes planning, accounting, and monitoring during the course of production, hampers the introduction of advanced forms of labor organization, and reduces the utilization of production capacity and material resources. This in turn is explained by the fact that, with extreme decentralization of tool production, it becomes more difficult for each shop to be allotted billets of the requisite size, type, and shape for manufacture of various tools produced in small lots. For example, the tool shops of the First of May Agricultural Machine-Building Plant in Belotserkovskiy employ about 280 different grades and types of metal. Because of comparatively low demand, the majority of them run below the provisional working

norms for metal deliveries. This causes the range of shapes produced by the plant to be curtailed and a considerable amount of product to require reforging. This results in excessive labor costs for machining, loss of metal "as waste", and reduction of tool quality.

In many instances, however, the production scale for tools conforming to state standards at machine-building plants, although considerable from the standpoint of a specific plant, is naturally far from the optimum output level for definite types of cutting tools and from the tool production at enterprises of the specialized tool industry. While the output of single-point tools at tool plants reaches 5-6 million units per year, that of thread-cutting dies is 7-15 million units, that of taps is 6-9 million units, that of reamers is 5-10 million units, that of milling cutters is 1-8 million units, and that of drills is 4-7 million units, the most common lot sizes for these tool types at tool shops are approximately 1-5, 5-10, and 10-50 thousand units per year respectively (see Table 3).

It is quite comprehensible that such lot sizes for the tools manufactured do not allow utilization of the same equipment that is employed for mass production of drills, milling cutters, taps, thread-cutting dies, and other types of cutting tools at specialized enterprises and the limited demand of each separate plant for tools of various types dictates the predominantly individualized manner in which this work is performed, the low level of technology and production organization, and hence the unsatisfactory production indices obtained. At many machine-building plants, the labor input for manufacture of cutting tools is 3-5 times or more that at tool plants.

One of the current deficiencies in the specialization of tool production is excessive duplication and decentralization in the manufacture of identical groups and types of tools and machining attachments. In 1979, for example, 312 of 337 tool shops at Ukrainian machine-building plants produced cutting tools, 276 produced measuring tools, 257 produced auxiliary tools, 324 produced dies for cold forging, and 285 produced molds. More than 90% of tool shops produce single-point tools, more than 65% manufacture milling cutters, 60% produce drills, more than 50% fabricate taps and reamers, and approximately 40% manufacture thread-cutting dies.

As a rule, the overwhelming majority of tool shops are general-purpose producers, manufacturing an exceedingly wide variety of tools and attachments. Many shops usually produce two classes of tooling (tools per se and machine-tool attachments), 7-8 tool sets, 10-12 types of cutting tools, as many as 60 tool varieties, and hundreds or thousands of standard sizes. Manufacture of so excessively wide a range of tools and machining attachments with comparatively low output for each tool shop is an obstacle to expansion of tool production. The technical outfitting of many tool shops not only fails to meet current requirements but also has a detrimental influence on the time needed for new products to be introduced in various sectors of the machine-building industry. All this leads to an increase in labor and material costs at tool shops, a rise in production costs, and prolongation of the time required for development of new machines, mechanisms, instruments, etc.

Table 3

Concentration of Production of Individual Types of Cutting Tools in Machine Building in the UkSSR for 1979

Annual output (units)	Number of plants manufacturing					
	Drills	Taps	Dies	Reamers	Millers	Cutters
Up to 100	13	13	8	15	19	1
101-500	35	39	59	50	49	9
501-1000	45	43	17	31	49	17
1001-5000	52	58	34	61	81	60
5001-10,000	30	14	3	18	16	48
10,001-50,000	18	15	7	9	18	102
50,001-100,000	-	5	-	2	2	39
100,001-250,000	3	-	-	-	2	16
250,001-500,000	3	-	-	-	-	6
More than 500,000	-	-	-	-	-	4

Costs for tool manufacture in tool shops depend on many factors, one of which is the average lot size for the tools produced. The larger the lot size, the greater (all other conditions being equal) are the opportunities for use of progressive manufacturing processes and advanced equipment, the better are material resources utilized, and the lower are labor costs. Calculations have shown that the differences in lot sizes amount to factors of 6635 for drills, 13,042 for taps, 932 for thread-cutting dies, 5917 for reamers, 4004 for milling cutters, and 5545 for single-point tools. The differences in cost levels are also very substantial: they amount to factors of 11 for drills, 13.4 for taps, 10.2 for thread-cutting dies, 7 for reamers, 13.5 for milling cutters, and 7.8 for single-point tools. This is indicative of serious shortcomings in tool-production organization and of a low organizational-technical level.

The inexpedience of producing many types of cutting tools in the tool shops of Soviet machine-building plants is also shown by the following data: the L'vov tool plant alone annually manufactures 5.6 times as many taps as the 192 tool shops at machine-building plants; the Khar'kov tool plant produces more than 14.4 million thread-cutting dies annually, whereas 128 tool shops have an output of only 228 thousand units; the annual output of reamers at the Vinnintsa tool plant is 6.7 million units while 188 tool shops produce 648 thousand units, an output lower by a factor of 10.3; milling-cutter production at the Zaporozh'ye tool plant is 7.7 million units, while that for 241 shops is lower by a factor of 7 (1.1 million units); two tool plants (Zaporozh'ye and Khar'kov) produce almost as many single-point tools (10.5 million) as 310 tool shops.

In his report to the XXV CPSU Congress, L. I. Brezhnev pointed out that there are major shortcomings in the expansion of specialization in the machine-building industry: "not all ministries and departments are undertaking active expansion of specialization, reallocation of resources to favor interindustry production facilities, and creation of special plants for manufacture of tools, machine-tool

attachments, and unified subassemblies and components. Repair facilities are too widely scattered. Such trends lead to substantial wastage of all types of resources" (Materialy XXV s"yezda KPSS [Proceedings of the 25th CPSU Congress], Moscow, Politizdat, 1976, p 45).

The above quotation has a direct bearing on tool production in the Ukrainian machine-building industry. The economy incurs substantial losses because of the manner in which tool production is organized. According to rough calculations, just the amount by which the cost of tools manufactured in the tool shops of Ukrainian machine-building plants exceeds current market prices creates annual losses of approximately 37-40 million rubles. It is also necessary to take into account the indirect losses due to the lower quality of tools manufactured by the tool shops of machine-building plants, the failure to completely satisfy the national-economic demand for tools, and the low degree of basic-equipment utilization by specialized shops in comparison with tool plants. In order for the demand of the Ukrainian economy for tools and attachments to be met, it is necessary to build new plants, expand and modernize existing tool-production facilities, improve intraindustry specialization, create a system for rental of general-purpose assembly equipment (USP) and special tools, organize large scale permanent departments and shops for reconditioning of worn tools, and enlarge the scope of projects directed at standardization, normalization, and unification of tools and attachments. Calculation shows that, once the program for expansion of the Urainian tool industry worked out by the UkSSR Council for Study of Productive Forces (Academy of Sciences of the UkSSR) has been implemented, there will be an increase in the level of centralization (from 15.3% in 1979 to 35% in future). There will also be a capital-investment savings amounting to 19.3 million rubles, a reduction in workforce by 8.7 thousand employees, and a savings of 57.4 million rubles in plant funds.

Along with measures to intensify and improve intraindustry specialization, on which most planning institutes are working, practical implementation of the proposed program for future expansion of the tool industry requires that a series of measures be taken to bring about rapid expansion of interindustry specialization. The most important of these is the further buildup of specialized tool industry capacity. This can be achieved by work on modernization, expansion, and technical reequipping of existing tool and attachment plants and by building new plants of optimum capacity for production of tools and attachments. According to the calculations that have been made, the capital investment needed for modernization, expansion, and reequipping of existing tool plants in the Ukraine is 29.4 million rubles. The capital investment required for expanded reproduction of production funds, chiefly through tool plant construction, should in the long run be 165.3 million rubles.

According to data from a number of industry planning institutes, the optimum capacity of plants for production of machine-tool attachments corresponds to a yearly output of 18-20 million rubles. The total value of attachments (exclusive of fixtures) that cannot be produced at existing plants will in future amount to 53.1 million rubles. It will therefore be necessary in the next few years to begin construction of three plants for manufacture of attachments. Calculations have

shown that the most expedient production structure for these plants should be roughly as follows: 52% dies for cold forging, 13.5% dies for hot forging, 21.5% molds, and 13% casting attachments. Enterprises for manufacture of dies, molds, casting attachments, and fixtures should be located in areas where machine building is highly developed. This is dictated, first of all, by the fact that these plants manufacture products that are not easily transported and they therefore should be located in direct proximity to the consumers, i.e., machine-building plants. Secondly, the production of dies, molds, casting attachments, and fixtures requires a highly skilled workforce and the presence of large design and planning bureaus and services.

The UkSSR Council for Study of Productive Forces (Academy of Sciences of the UkSSR) utilized the methodological approach proposed by V. T. Chumanenko for selection of the most effective siting arrangements for tool plants in populated areas (cities) of the republic (V. T. Chukhmanenko, Opredeleniye ekonomicheskoy effektivnosti razmeshcheniya promyshlennykh predpriyatiy [Determination of the Cost-Effectiveness of Industrial-Plant Siting], Kiev, SOPS USSR AN USSR, 1976).

Proceeding from the standpoint of criteria for effective siting of new plants, with consideration given to the demographic situation in the republic and the need for development of new small and medium cities and for rational utilization of labor resources, it would be most expedient to locate plants at Pavlograd (Donets-Dnepr economic district), Stryy, and Belaya Tserkov (Southwestern economic district). Calculations have shown that the resultant provisional savings will exceed 3.8 million rubles.

Major opportunities for improving production efficiency are associated with reconditioning and recycling of many types of tools and attachments. The most important way to increase the efficiency of tool reconditioning and attachment repair is centralization of these operations.

According to studies carried out at the Ukrainian State Planning Institute of the Machine Tool Industry, Ukrainian State Planning, Technological, and Experimental Institute for Organization of the Machine Tool and Tool Industry, and a number of other institutions, the optimum size of a centralized reconditioning facility intended to serve localities on the scale of economic districts and regions can be characterized by the following indices: 104 pieces of machining equipment, six heat-treatment units, 11 chrome-plating units, a staff of 250, including 160 production workers, and a total area of 2200 m^2, including 1300 m^2 in the machine department, 120 m^2 in the chrome-plating department, 180 m^2 in the heat-treatment department, 300 m^2 in the grading area, and 300 m^2 in the finished tool and attachment warehouse.

Analysis of research data shows that, in the long run, it will be expedient to create 18 facilities for centralized tool repair and reconditioning operations. Of these, nine should be in the Donets-Dnepr economic districts, seven in the Southwestern economic district, and two in the Southern economic district. The total capital investment for creation of the facilities will be 21.2 million rubles. Computation has established that the proposed organization of repair and

reconditioning operations will permit a savings of 15.7 million rubles and free 2.6 thousand workers in comparison with decentralized operations. Amortization of costs will require less than a year.

The ever greater complexity of machines and equipment and the continually more stringent requirements imposed on their precision and quality necessitates design of new tools for all machining, assembly, welding, and forming operations. As was emphasized above, the most effective type of tooling for multiple-product manufacturing in which there are frequent changes in the machines in production is currently use of standard multipurpose adjustable attachments of the USP type. Development work carried out by individual planning institutes and special design bureaus (the Kramatorsk Scientific-Research and Planning-Technological Institute of Machine Building and the Moscow office of the Technical Bureau of the Soyuztekhosnastka Association) has shown that the most expedient applications of USP are in the organization of major rental centers in economic districts (with branches to serve groups of plants) and stocking of complete tool sets at large specialized plants.

As investigations conducted by the UkSSR Council for Study of Productive Forces have shown, satisfaction of the demand for general-purpose adjustable attachments and achievement of a savings of the order of 46.7 million rubles through utilization of USP systems will require establishment of ten central (stocking 250 thousand units) and five local (100 thousand units) USP rental facilities, as well as four branches. The most expedient sites for central rental facilities are Khar'kov, L'vov, Odessa, Kiev, Dnepropetrovsk, Kramatorsk, Kremenchug, Voroshilovgrad, Sumi, and Melitopol; the best locations for local facilities are at Zaporozh'ye, Kherson, Nikolaev, Vinnitsa, and Berdyansk; branches of the central facilities are best set up at Khmelnitskiy, Poltava, Zhitomir, and Kirovograd. In connection with the rather strained labor-resource balance in the republic (especially in the oblasts covered by the Donetsk-Dneprov economic district), it is advisable that these facilities be organized on the basis of existing major tool plants, without employing additional workers.

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PRICE FORMATION FOR MACHINEBUILDING COMPONENTS

Kiev EKONOMIKA SOVETSKOY UKRAINY in Russian No 7, Jul 81 (signed to press 17 Jul 81) pp 52-56.

[Article by E. Shaboltas, candidate of economic sciences, and I. Vishnevskiy]

[Text] There exists no sector of the machine-building industry that does not acquire, through industrial cooperation, ready-made components needed to assemble manufactured products. The cost of the components is included in the net cost and price of the final product, thus influencing these factors and necessitating a scientific foundation for component pricing. In this connection, the subsection devoted to pricing of new components in the current "Methods for determining wholesale prices of new industrial and technical products" issued by the State Committee on Prices of the Council of Ministers of the USSR (1974) requires further expansion and refinement. Improvements should, in our opinion, be directed primarily at giving consideration in pricing to the fundamental indices of the technical-economic advantages of new components, which are not reflected by Eqs. (4-6) of the guidelines in question, and at refining the structure of these formulas.

Component pricing has its own characteristics. These are dictated by the specific nature of components which are not finished products. Specifically, they are characterized by a great diversity of possible functions. The result yielded by implementation of these functions is not measured directly in terms of product output or services provided to satisfy societal requirements, but is rather manifested in the provision for and improvement of operating characteristics in the assembled equipment. Thus, in contrast to finished products, e.g., machinery, power facilities, means of transport, etc., the effectiveness of new types of components cannot, as a rule, be quantitatively expressed by their throughput indices, e.g., annual product output or performance. This important (generalizing) index proves to be unsuitable in practice not only for evaluating the comparative effectiveness of components belonging to different groups, but also for determining that of components with different functions within a single homogeneous group.

For all the diverse specific manifestations of the technical-economic advantages of new components with various functions, their operational effectiveness may be expressed by the following basic indices:

- the improvement in the main operating parameters of the assembled equipment (throughput, capacity, carrying capacity, speed, quality of manufactured products,

etc.);

- the rise in technical level and expansion of component functional capabilities, permitting a decrease in the number or composition of the components employed in the equipment being assembled;
- the increase in the durability and reliability of new components;
- the reduction in consumer operating costs.

Pricing also necessitates determination of the effectiveness of new components from their individual technical-economic advantages over interchangeable or similar components. This in turn makes it necessary to correct the calculated maximum price for a new component that differs from a standard component in having some definite advantage. Moreover, the specific properties of components are such that it is necessary, in our opinion, to provide an opportunity for using the aggregative method to determine the maximum price in cases where a new component replaces several types of functionally different components employed previously.

From our standpoint, it is also necessary to introduce refinements into existing pricing methods. Essentially, in calculating the maximum price of components having a service life that is defined in their documentation not in time units (hours, months, or years) but in terms of amount of work performed (for example, kilometers travelled for tires), we replace the service-life ratio in time units for the standard and new components that is used in all other longevity calculations

$$(1/T_s + E_n)/(1/T_n + E_n)$$

with the ratio of the performance levels for the standard and new components W_n/W_s. However, this type of calculation neglects the influence of the constant E_n, which affects the results. In order to eliminate the discrepancy in the results yielded by various calculation methods, the service life (longevity) of components should be expressed solely in time units. If this parameter is expressed in terms of performance (cycles, reciprocal motion, travel, etc.) in standard technical documentation, then it should be converted to terms of time by using the standard or empirically established operating load over the corresponding time unit in calculating the maximum price of new components. The need to adopt this proposal can be illustrated by calculation of the maximum price of a type 3M manometer turn-on valve, whose specified operating life is measured in millions of cycles.

Here we have the following initial data: C_s = 34 rubles, W_s = 6 million cycles, W_n = 10 million cycles, an annual operating load of 4 million cycles, and $E_n =$ $= 0.15$.

The formula for calculation of P_m from the service-life expressed in time units (years) is:

$$P_{max} + (1/t_s + E_n)/(1/t_n + E_n) = 34 \cdot (1/1.5 + 0.15)/(1/2.5 + 0.15)$$
$$= 50 \text{ rubles } 69 \text{ kopeks}$$

Calculation of P_m from the performance ratio with Eq. (6) of the State Committee on Prices method yields:

$$P_{max} = P_s(W_n/W_s) = 34 \cdot (10/6) = 56 \text{ rubles } 68 \text{ kopeks}$$

This example clearly shows that such substantial discrepancies in the values of P_{max} calculated for a single component having identical technical-performance parameters are impermissible and confirm the invalidity of calculations made with Eq. (6), which was adopted in a departure from the general method of expressing service life in years of operation. For the purpose of fuller appraisal of these special characteristics of components in pricing and particularly in determining maximum component prices, we devised an sector-specific "Method for determining wholesale prices for hydraulic, pneumatic, and lubricating equipment and filter systems". This method specifies the basic premises for determining wholesale prices for hydraulic and pneumatic equipment with general applications in machine-building, covering all elements of hydraulic, pneumatic, and lubricating systems for machine tools, forges, presses, foundry and wood-working machinery and other equipment used in machine-tool building practice, as well as various hydraulic mechanisms used in other sectors of the machine-building industry.

Despite its sector-specific designation, the method does not have a narrowly specific character, since it was based on general features and principles of price formation common to all machine-building components and may thus in our opinion be utilized in component pricing in different sectors of the machine-building industry.

Taking pricing requirements into account, new components are subdivided by the method into the following basic groups: a) components intended to replace those previously employed; b) components that are an extension of a definite parametric series of previously developed components; c) essentially new components being used in the USSR for the first time. The general formula for determining the maximum price of a new component is:

$$P_{max} = P_s \cdot a \frac{\frac{1}{t_s} + E_n}{\frac{1}{t_n} + E_n} + \frac{X_s - X_n}{\frac{1}{t_n} + E_n} \pm \Delta K$$

where P_s is the price of the standard component in rubles, a is the interchangeability coefficient for the standard and new components, X_s and X_n are the consumer's annual operating costs for use of the standard and new components, without deductions for reconditioning (rubles), t_s and t_n are the service lives of the standard and new components respectively (years), E_n is the normative coefficient of capital-investment efficiency (0.15), and ΔK is the change in concomitant consumer capital costs with utilization of the new component (rubles).

The standard component is assumed to be a progressive one, the best of Soviet-produced components, and generally in serial production. The wholesale price of the standard component is adjusted for the cost level corresponding to the year of serial new-product manufacture and the established profitability norm for the product group in question.

If the service life of a component (t) is expressed in terms of number of hours in operation or number of cycles, it can be converted to calendar years by means of the formula:

$$t = \frac{P}{F_g \cdot \mu},$$

where P is the service life of the component in hours or cycles, F_g is the actual annual time on line for the component, expressed in the same measurement units, and μ is a coefficient characterizing the proportion of component operating time in the actual operating time of the equipment being assembled.

The operating expenses of component consumers are composed of expenditures for repair and replacement of wornout parts, electricity, water, the wages of production workers, and the cost of basic and subsidiary materials required for product manufacture.

As a rule, the concomitant capital investment changes very little or not all for most components; the following formulas for determining the maximum price thus omit this parameter (ΔK).

The interchangeability coefficient (a) for various types of components is determined by the ratio of the appropriate basic technical-economic indices.

If an increase in throughput (capacity) or improvement of other operating parameters causes the number of components simultaneously being utilized in the equipment being assembled to increase, then the interchangeability coefficient is expressed in terms of the number of standard (k_s) and new (k_n) components simultaneously utilized. In such cases, the maximum price of a new component is determined from the formula:

$$P_{max} = C_s \cdot \frac{k_s}{k_n} \cdot \frac{\frac{1}{t_s} + E_n}{\frac{1}{t_n} + E_n} + \frac{1}{k_n} \cdot \frac{X_s - X_n}{\frac{1}{t_n} + E_n},$$

where k_s and k_i are respectively the numbers of standard and new components simultaneously utilized.

In cases where the component has no direct analog but replaces an assembly (set) composed of several older components belonging to a different functional type but

performing the same function in the assembly, the entire group of devices to be replaced is taken as the standard component in the calculations. The maximum price for the new component is determined from the formula:

$$P_{max} = P_{s1} \cdot \frac{k_{s1}}{k_n} \cdot \frac{\frac{1}{t_{s1}} + E_n}{\frac{1}{t_n} + E_n} + P_{s2} \cdot \frac{k_{s2}}{k_n} \cdot \frac{\frac{1}{t_{s2}} + E_n}{\frac{1}{t_n} + E_n} + \cdots +$$

$$+ P_{si} \cdot \frac{k_{si}}{k_n} \cdot \frac{\frac{1}{t_{si}} + E_n}{\frac{1}{t_n} + E_n} + \frac{1}{k_n} \cdot \frac{X_s - X_n}{\frac{1}{t_n} + E_n},$$

where i is the number of assembly types to be replaced by the new component.

In both cases, the annual consumer operating expenses (X_s and X_n) are calculated for all the standard and new components respectively that are simultaneously utiized in the equipment being assembled.

If the improvement in the operating characteristics of the new component leads to an increase in throughput for the equipment being assembled, the interchangeability coefficient is expressed by the ratio of the annual performance levels with utilization of the standard and new components. The maximum price is determined from the formula:

$$P_{max} = P_s \cdot \frac{W_n}{W_s} \cdot \frac{\frac{1}{t_s} + E_n}{\frac{1}{t_n} + E_n} + \frac{X_s - X_n}{\frac{1}{t_n} + E_n},$$

where W_n and W_s are respectively the amounts of work performed annually by equipment utilizing new and standard components, provided that the increase in production (amount of work performed) is directly associated with the use of the new component.

If individual indices of the new and standard components remain unchanged, then they are not employed in the calculations and the maximum price of the new component is determined from the following abridged formulas:

- with identical service lives for the new and standard components:

$$P_{max} = P_s \cdot \frac{k_s}{k_n} + \frac{1}{k_n} \cdot \frac{X_s - X_n}{\frac{1}{t_n} + E_n}; \quad P_{max} = P_{s1} \cdot \frac{k_{si}}{k_n} + P_{s2} \cdot \frac{k_{s2}}{k_n} + \cdots +$$

$$+ P_{si} \cdot \frac{k_{si}}{k_n} + \frac{1}{k_n} \cdot \frac{X_s - X_n}{\frac{1}{t_n} + E_n}; \quad P_{max} = P_s \cdot \frac{W_n}{W_s} + \frac{X_s - X_n}{\frac{1}{t_n} + E_n};$$

- with identical annual consumer operating expenses for utilization of the new and standard components:

$$P_{max} = P_s \cdot \frac{k_s}{k_n} \cdot \frac{\frac{1}{t_s} + E_n}{\frac{1}{t_n} + E_n}; \quad P_{max} = P_s \cdot \frac{k_{s1}}{k_n} \cdot \frac{\frac{1}{t_{s1}} + E_n}{\frac{1}{t_n} + E_n} + P_{s2} \cdot \frac{k_{s2}}{k_n} \cdot$$

$$\cdot \frac{\frac{1}{t_{s2}} + E_n}{\frac{1}{t_n} + E_n} + \cdots + P_{si} \cdot \frac{k_{si}}{k_n} \cdot \frac{\frac{1}{t_{si}} + E_n}{\frac{1}{t_n} + E_n}; \quad P_{max} = P_s \cdot \frac{W_n}{W_s} \cdot \frac{\frac{1}{t_s} + E_n}{\frac{1}{t_n} + E_n} .$$

The minimum price (P_{min}) of a new component is determined from the formula $P_{min} = C(1 + Pr_n)$, where C is the cost used as the base for the wholesale price (that in the second or third year of serial production) and Pr_n is the sector profitability norm with respect to component cost.

The wholesale price of a new component is determined on the basis of the minimum price, taking into account the effectiveness of the new product. The effectiveness of the new component is checked by establishing whether it satisfies the condition $P_{max}/(P_{min} + E_{sn}) > 1.15$, where E_{sn} are the unit costs for preliminary work and setup of serial production for the new product. Depending on the value of this ratio, the standard scale given in the publication "Methods for determination of wholesale prices for new industrial and technical products" (State Committee on Prices, 1974) is used to set the incentive surcharge on the minimum price (additional profit), which comes from the consumer savings realized that can be allocated between consumer and manufacturer through pricing. The allocable savings is determined from the formula:

$$S_a = P_{max} - (P_{min} + E_{sn})(1 + K_m)$$

where K_m is a coefficient representing the minimum amount by which the maximum price of the new product exceeds the sum of the minimum price and the costs of preliminary work and setup for the new product ($K_m = 0.15$).

In this case, the formula for the wholesale price of the new component has the form:

$$P_{who} = P_{min} + Su_p$$

where Su_p is the incentive surcharge (additional profit) and is determined as a differential function of the ratio $P_{max}/(P_{min} + E_{sn})$; then $Su_p \leq 0.5\ S_a$.

The wholesale prices for new components that belong to and consititute an extension of a definite parametric series are determined on the basis of the relationship established for the series between changes in the technical-economic parameters of the components and the corresponding changes in their prices (ignoring incentive surcharges if any were approved for the earlier product). In this case, the price is a function of basic parameters:

$$P_a = f(x_1, x_2, \ldots, x_n)$$

where P_a is the adjusted price and $x_1, x_2, \ldots, x_n$ are component technical-economic parameters.

Construction of a model of the relationship between the prices of components and changes in their technical-economic parameters includes the following steps: identification of classified parametric groups for the components under investigation; selection of the parameters with the strongest influence on component price; selection and justification of the form of the relationship between the prices of the components and their technical-economic parameters by means of regression analysis.

Our investigation established appropriate mathematical formulas that can be employed in the machine-building industry for pricing parametric component series for hydropneumatic lubricating equipment and filtration units. Examples are provided by NRM radial piston pumps ($P = 67.623130Q^{0.115574} \times G^{0.36581}$), G29 hydraulic cylinders ($P = 19.218215 + 13.373724W + 0.675238G$), AR pneumatic-hydraulic accumulators ($P = 98.319559\varepsilon^{0.242517} \times G^{0.099724}$); 0.08S421 screen filters ($P = 2.963812Q^{0.149517} \times G^{0.202148}$), and K-4 lubrication pumps ($P = 20_n^{11.5}$), where Q and W are the working capacities in liters/min, G is the mass in kg, ε is the gas-chamber capacity in dm^3, and n is the number of working branch lines.

An incentive surcharge in the form of additional profit (generally 50% of the rated savings) is added to the price found for a highly effective product by the parametric method.

The aggregative method for determination of wholesale prices is used in the following cases: a) the price or cost of a product constitutes the sum of the prices or costs of the standard elements composing it; b) a substantial (dominant) proportion of the cost of a new product is accounted for by the sum of the prices of the components purchased; c) the new product differs from the standard model in the design of individual assemblies and its price is based on that of the standard product and the differences in cost for the assemblies replaced.

The same versions of the aggregative method (a, b, c) are employed for parametric pricing of individual constituent elements (assemblies). In this case, the prices

of the assemblies are determined by the parametric method and the final price of the entire product is established by the aggregative method.

Some major examples of the use of the aggregative pricing method include:

1. Twin and composite impeller pumps. The cost (price) of the product is determined as the sum of the prices of the pumps composing the unit, with a correction for the actual coefficient of reduction (increase) in expenses.

2. Pump installations. The cost (price) is determined by the aggregative method. The cost of the pump and fittings is calculated from a parametric relationship, using the same parameters as for the pump. The cost of the electric motor is determined from its list price, with appropriate additional charges (transportation costs and profit).

3. Displacement-type hydraulic transmissions. The cost (price) is determined by the aggregative method, as the sum of the prices of the systems included in the transmission. The price of each system is calculated from its basic parameters.

4. Hydraulic stations and mechanisms. The cost (price) is determined by a composite method: all the components purchased are assigned their list prices and all the other assemblies fabricated by the manufacturer (tanks, cabinets, mounting fixtures, and piping) are considered to represent steelwork and their price is determined as a parametric function of a single parameter, their mass.

The methodological premises described above can, when used for pricing in other sectors, be made more specific by taking into account the individual characteristics of components intended to serve other purposes.

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METAL-CUTTING AND METAL-FORMING MACHINE TOOLS

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FACTORIES STRUGGLE TO OBTAIN INDUSTRIAL ROBOTS

Moscow EKONOMICHESKAYA GAZETA in Russian No 11, Mar 83 p 14

[Article by V. Kozin, chairman of the Scientific-Methodological Council on Robot Engineering for the CPSU Obkom and Yu. Suslov, scientific secretary of the Council, Novosibirsk: "A Robot Will Not Come into the Shop by Itself"]

[Text] At one of the sessions of the Council for Assistance to Scientific and Technical Progress which is part of the party obkom, the following question came up: "At what stage is robotization of production in the enterprises of Novosibirsk and the oblast? What has been done, and what is planned for the near future?"

Let us tell you directly: there was no clear, concrete answer. Uncoordinated data from the plants and associations attested to the fact that work is in progress. Something is being introduced somewhere. But the complete picture of how never unfolded. At the same time, experience insistently required that a unified program of efforts be formulated for the five-year plan, that the actual capabilities of the enterprises be clarified and finally, that the efforts be coordinated.

It was with this aim in mind that the scientific-methodological council on robotization and robot engineering, consisting of scientists, enterprise engineers and party workers was created. We couldn't get by without arguments as to whether still another council was needed and would it not become a superfluous superstructure. Its practical activity expelled all doubts completely.

Advantages of a comprehensive program

Relying on the assistance of the active membership, the council in a short time organized a study of 30 machine building plants, generalized the data from the analysis and assembled the requests for the necessary robot machinery.

Then, on the basis of actual facts and projects, a comprehensive program for introducing industrial robots and manipulators at the oblasts' enterprises was worked out and affirmed at the start of 1981. It was planned to

incorporate no less than 500 robots, set up robotized workships at the Berdsk radio plant and at the "Elektroagregat" association and put automated sectors using robots into operation at 7 machine building enterprises by the end of the five-year plan.

Work based on the principle of "Deliver the technology where you can!" gave way to precise planning. In just the first year, 110 industrial MP-9s robots were invented at the "AvtoVAZ" association with the participation of members of the scientific-Methodological Council. All of them reached plants quickly.

But unforeseen difficulties arose. It was a new matter in all regards for a majority of the enterprises: there was no experience in incorporating the units, and there were no engineers familiar with robot technology. It was difficult to deliver the instructional materials to the site, although the main scientific establishments on robot engineering were working them up. With the aid of the Novosibirsk NTI [Scientific and Technician Information] Center, the council organized dissemination of the needed materials to more than 250 plants and to the institutes of Novosibirsk.

As is known, there are low-level organizations in any city for dozens of various scientific-technical societies. How can they participate concretely in realizing the problems of robotization? This question was also placed on the agenda. But the fact that there are sections for introduction of robot technology working as part of the technical economic councils of a majority of Novosibirsk's party raykoms, and that the scientific-technical societies have developed a concrete program within this realm is also the result of our council's efforts. The Lenin and Zayel'tsovskiy party raykoms, for example, conducted seminars to exchange experiences in introducing robot technology at some enterprises.

A useful initiative was shown by the technical-economic council of the Zayel'tsovskiy raykom CPSU, which developed an information chart. The chart contains the primary data for each manipulator in operation at a given enterprise. The oblast NTO [scientific and technical society] council, the NTI center and scientific research institutes started to work on this problem more intently.

At the same time, the council was studying the possibilities for training the necessary specialists on site. For the time being, 4 VUZ's produce engineers in robot engineering. It would be wrong to count just on them. In accordance with the comprehensive program, a department of production automation and robot engineering was opened at the People's University of Science and Engineering as a part of the Novosibirsk party gorkom.

At the enterprises, they got rid of a lot of the "amateurism" and working by by feel. Our council is solving many related questions in a competent manner. And the fact that other large collectives (the Novosibirsk "Tyazhstankogidropress" plant, that of a metallurgical combine and of "Novosibirskmebil'" association) joined the 24 enterprises which were originally included in the comprehensive program attests to the scale to which the scientific work has been expanded.

Barriers Artificial and Real

In speaking about organizational matters, we are far from the idea that there remain no unresolved questions in the area of production robitization at the enterprises of Novosibirsk. Yes, there are robots, and more and more of them appear in the various sectors, but the truth is that no robot will come into the shop by itself.

But the conversations about psychological barriers which are even now coming up reflect as a rule the extent, first of all, to which production is unprepared, the lack of technical-economic bases for the utilization of robot technology.

It is no secret that the price of a series-[produced] robot of average complexity is rather significant, some R20,000-40,000. It is necessary to use a robot device for 3 shifts a day in an automated sector in order to pay off the costs rapidly. Experience indicates that the greatest economic effect is achieved when a robot is included in a complete industrial process. Idle time is very costly for a machine as complex as a robot.

Highly organized production is necessary to avoid losses. And we have assured ourselves in practice that if these conditions have not been established at an enterprise, they immediately start making references to the so-called psychological barrier, supported by complaints of a lack of personnel.

These vexing barriers, to overcome which requires a lot of time, paperwork and negotiations, have not been eliminated thus far. Let us present some examples taken from industrial experience. Two neighboring plants are ready to exchange robots of different models, but without the approval of their ministries, they cannot do this. Finally the problem is resolved satisfactorily, but how much effort is wasted on correspondence!

Another example. We decided to supply a municipal consultation set up at the educational center of Minstankoprom [Ministry of the Machine Tool Building Industry] with samples of robot technology. This ministry's plant can transfer robots to the academic facility under specific conditions, but it must first buy them somewhere. At the same time, a neighboring plant, but from a different department, agrees to sell a robot it does not need. However it lacks permission from its ministry. The question took almost an entire year to be resolved. An it could come up again tomorrow, and the complex maneuvers will have to be repeated from the beginning.

The experience of introducing the first industrial robot at the Novosibirsk Leather-Shoe Association "Ob'" is instructive. It was set up in one of the most labor-intensive sections of the rawhide plant, where the raw material undergoes preliminary processing. A worker had to take up to 20 kilograms of the intermediate product from a bale and lay it on a table. And he had to do this for an entire shift. It was just the right operation for a robot, but where could one get it? RSFSR Minlegprom [Ministry of Light Industry] responded with a denial. Members of the robot engineering section

with the Zayel'tsovskiy party raykom responded to management's request; they found the necessary robot at one of the machine building plants. The benevolent relationship between the management of the two enterprises and the persistence of the party raykom permitted the rawhide plant to acquire a robot with a lifting capacity of 25 kilograms. It was modernized slightly, and it is now coping successfully with the tedious operation. At the enterprise, this step stimulated the further development of robotization. But now the position of the ministry is unclear. The interest is not visible.

By the way, this example reflects one of the trends in the activity of the oblast's scientific-methodological council on robot engineering to take an orientation not only toward machine building plants, but to the reduction of manual labor at enterprises of the light and food industry and the oblmestprom [Oblast Administration of Local Industry] as well. Who does not know that mechanization is very necessary in precisely these sectors?

Taking into consideration the fact that now machine building ministries are increasing production of various robot models for diverse purposes, to be delivered to enterprises in a centralized order, it is apparently necessary for USSR Minvuz [Ministry of Higher and Secondary Specialized Education] and the USSR State Committee on Professional and Technological Education to accelerate training of personnel in this area of engineering and technology.

It is necessary to make the robotization process comprehensive, as was called for by decisions of the 26th Party Congress.

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THIRTY YEARS OF RED TAPE DELAYS INTRODUCTION OF NEW CHUCK

Moscow TRUD in Russian 4 Feb 83 p 2

/Article by B. Gafiatulin, TRUD correspondent, Alma Ata: "Obstinacy or Incompetence?"/

/Text/ The state is losing millions of rubles due to red tape over the wide-spread introduction of a valuable invention capable of raising the labor productivity of lathe operators.

I found Ivan Fedorovich Babenko at his country house. He was obviously delaying the unhappy conversation on a topic that is strictly forbidden in his house. Yes, too much effort, both physical and spiritual, has been wasted fighting red tape. The innovator was already on pension and the main purpose of his life had not moved from a dead stop.

...This story began 30 years ago. I. F. Babenko, a young engineer at the Alma Ata heavy machine building plant, built a new chuck (this is what the device for holding blanks on a lathe is called). The innovation had a number of advantages over the ordinary three-jawed chuck with which most machine tools were outfitted up until that time. As a rule, the old chucks broke down after a year or year and a half of operation. It cost 10 times as much to repair them as to manufacture a new one. Enterprises were suffering heavy losses.

The service life of the new chuck is 10-12 years. Moreover Babenko's design takes less time in comparison with the old one to put in and remove the parts being worked. The chuck may be tightened and lossened in any stopped position, and it weighs 7 kilograms less. The Alma Ata workers joyfully incorporated the invention at their enterprise. The results exceeded all expectations. Each chuck permitted an annual savings of R480, and the lathe operators' work was made easier.

"They incorporated the invention at one plant, that was fine," the innovator argued, "but there are hundreds of this type of enterprise in the country and tens of thousands of machine tools. What benefit would it be to the state if we equipped them all with new chucks?"

Ivan Fedorovich addressed himself to the Moscow Experimental Scientific Research Institute of Metal Cutting Machine Tools (ENIIMC) of the machine tool and tool building industry with this proposition. This scientific establishment is responsible for technical politics in its sector. Without the approval and permission of the institute, no ministry will undertake serial introduction of an invention.

In essence, Ivan Fedorovich offered the scientists an efficient way to solve a problem which had been troubling them for a long time. It would seem that they should graciously take the invention of an engineer and help him introduce the new product into production. In the final analysis, who invented the chuck is not so important. The final result is important, what it provides for the national economy.

But A. Prokopovich, the former deputy director of ENIIMS had his own point of view. With indomitable energy, he started to demonstrate that the innovator's invention was worthless. We made contact with A. Prokopovich, who is now an advisor on science and technology for GKNT /State Committee of the USSR Council of Ministers on Science and Technology/ machine building administration, and asked him to give the main arguments against the Babenko chuck. Perhaps he had arrived at a different opinion since that time?

"I think that nothing has changed since then," answered Prokopovich. "Babenko's chuck has two major shortcomings. First of all, they are hazardous when in operation, and secondly, they are no better than the existing ones. There is no sense producing them."

Is that really so? Even at the time when there was an ongoing battle over the invention, there were no serious bases for the conclusions which were given. And this is why. Representatives of various plants in other cities frequently came to the Alma Ata plant. They saw how the new product worked and, upon their return home, they took one of the innovator's chucks with them without fail and reproduced it at their enterprises. At the same time that the colleagues at the ENIIMS were demonstrating that the chuck was dangerous in operation, it had already been spinning on thousands of lathes at more than 20 of the nations enterprises for a good 10 years, and not a single injury had been recorded due to design imperfections, not only those years, but all 30 years it had been in use.

As concerns the second conclusion, which chuck is best, a letter recently arrived in Alma Ata from Sverdlovsk. It was signed by 149 lathe operators from the famous "Uralmash" with from 2-43 years of working experience. "At our plant," the workers write, "the chuck designed by Babenko has been used for more than 25 years with great success. They are very convenient when doing rough-out and finishing on parts. We consider the design of this chuck to be simpler and more economical than the standard model. The fact that it makes the work of the machine tool operators easier and is safe in operation are also among the new chuck's merits. It is entirely incomprehensible why series production of the new product has not been organized."

The innovator has been trying to convince the colleagues at ENIIMS of the promise for the new chuck for almost 20 years. Skilled workers acknowledged long ago his invention and tried as hard as they could to get it introduced, whereas the scientists continue to resist. Commissions which were assembled to test the new item found the most diverse grounds for not giving it a start in life.

Here is a typical example. Routine tests of experimental prototypes of the chuck were being conducted. The mission rejected them on the grounds that they were made from a different class of steel and were of smaller diameter. It is entirely natural that chucks assembled with crude violations of technology are unable to demonstrate their qualities.

The innovator proposed that the commission go to any enterprise where the chucks had been working for more than a year and evaluate them there under plant conditions. But the scientists were obviously in no hurry to do this.

Then the innovator turned to the USSR State Committee on Science and Technology. He hoped that they would support his new product and help organize its series production. The deputy head of the GKNT Machine Building Administration B. Lyskov responded to the inventor. He made reference to the fact that the innovator's chuck was dangerous in operation, and therefore it was impossible to produce it serially.

This answer and those numerous routine replies ENIIMS had written Babenko were as alike as two peas in a pod. Is it possible that today B. Lyskov thinks otherwise? It is impossible to close ones eyes to the chuck's 30 years of excellent operation.

"I consider, as before," he said, "that the chuck is dangerous in operation and that it does not exceed existing models on the basis of its characteristics, and it is not worthwhile to stir up this story again. So many years have passed..."

It would be interesting if comrade Lyskov were to meet up with the "Uralmash" lathe operators who wrote the letter to Alma Ata. How could he convince them that the chuck is worthless?

It must be said that the numerous functionaries to whom the innovator turned sought ways to respond to him pro forma and not help him. Otherwise, how can one explain the fact that the engineers and lathe operators who worked directly with the chuck unanimously demand that its series production be introduced more rapidly. Here are opinions from some of the production workers:

"Babenko's chucks have undergone a lengthy testing under plant conditions at "Uralmash" and other plants. It is impossible to understand what other testing they need. They just have to be introduced," says the representative of the Sverdlovsk Oblast Council of Innovators Yu. Kudryavtsev.

"Ivan Fedorovich's chucks are working one of our mechanical assembly shops without breakdown. We do not have enough resources to equip all the shops

with them. I think it is necessary to accelerate mass production of the new item, in spite of the resistance of the scientific authorities," says the deputy to the Chief Technologist of the Leningrad plant "Russkiy dizel'" V. Kocherov.

One could give numerous similar testimonials. Is any further evidence of the need and the utility of the new item needed? I think not. The faultless, lengthy operation of the chuck has demonstrated its right to exist.

Specialists have calculated that wide scale introduction of the new item will produce an annual savings of 50,000-60,000 tons of scarce steel, it will save millions of rubles due to a decrease in chuck weight and it will increase the lathe operators' labor productivity. We hope that the management of the GKNT and the Ministry of the Machine Tool and Tool Building Industry will help the chuck take its place on the "holder" and render unto those who shove sticks into the wheels of a promising innovation their just desserts.

9194
CSO: 1823/57

NUMERICAL CONTROL JIG-TURRET PRESSES

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 4, Apr 82 inside back cover, back cover

[Text] These presses are intended for manufacturing flat parts from sheet metal, with holes of different shapes and sizes and complex internal and external contours.

The tools (punches and dies) are mounted on a turret. Each position has separate blank holders and strippers, ensuring high-quality punching. The jig layouts are precision units making it possible to precisely locate the blanks in the required positions.

The presses are equipped with mechanisms for handling the blank, notching and finishing the contours by milling, which substantially expands their technical capabilities.

The numerical control unit ensures automated operation of the presses in all modes and the machining of highly complex parts.

A press with a force of 1,000 kN is currently being introduced.

Basic Specifications

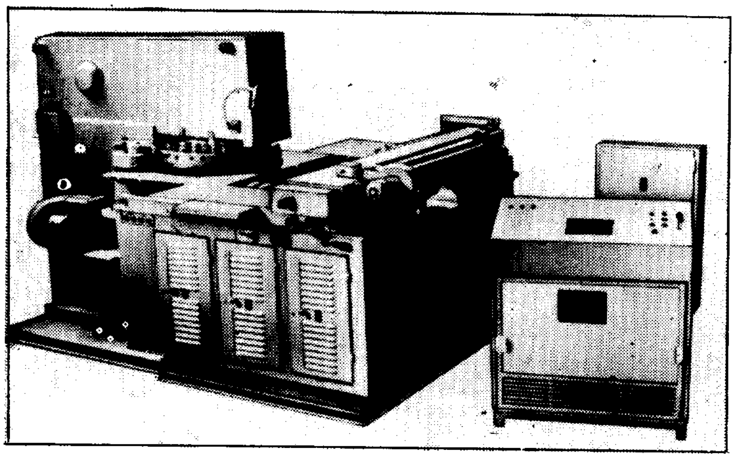
	K0122BP	K0126P	K0128P
Nominal force	160	400	630
Number of sets of different dies in turret	28	28	32
Maximum thickness of punched metal, mm	6	6	8
Maximum dimensions of workpiece, mm	800X1,000	1,000X1,200	1,200X1,200
Precision of hole and contour coordinates, mm	0.15	0.2	0.2
Speed, m/min:			
Notching		0.4-1.0	
Milling		up to 6	
Dimensions, mm:			
Horizontal	2,460X4,110	3,870X2,500	4,000X5,160
Height above floor	2,065	2,065	3,085
Weight, t	9.5	13.0	20.0

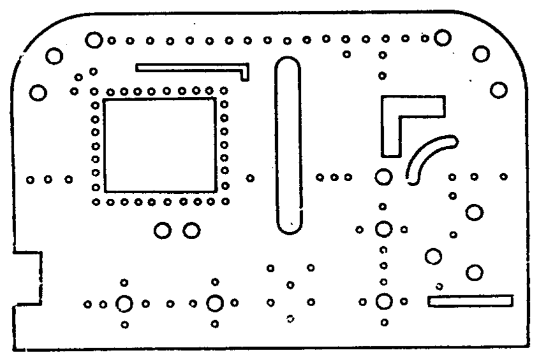
Main Advantages of Presses: Higher productivity when machining complex shapes; higher precision and stability of dimensions; simplicity of setting up programs and operation; better working and production conditions; savings on cost and materials for attachments.

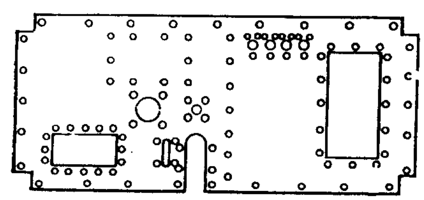
The economic effect (estimated) of the introduction of one press is 25,000 to 100,000 rubles, depending on the types of products and production series, thanks to higher quality and labor productivity.

Jig-turret hole-punching presses are employed extensively at plants in the radio engineering, electrical engineering, instrument-building, aviation and other industries.

Manufacturer: Chimkent Production Association for the manufacture of Forging-and-Pressing Equipment (486008, Chimkent, Ul. Ordzhonikidze, 28).







Model K0122BP Jig-Turret Press
With Programmed Control

9681
CSO: 1823/62

OTHER METALWORKING EQUIPMENT

HYDRAULIC SHEET BENDING PRESSES WITH PROGRAMMED CONTROL

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 4, Apr 82 inside back cover, back cover

[Text] These presses are designed for multiple position bending of strip or sheet metal according to a given program, with one installation of the blank on the press.

The program for hydraulic sheet bending presses is computed by the analytical method according to the drawing of the part. The maximum number of programmed points for each coordinate is 10. The programed values include the adjustment of the distance between the table and the ram and the displacement of the end rest.

The program is keyed in at the panel of the programmed control system with the help of a keyboard. The distance between the table and the ram is regulated by a separate drive controled by the unit. The value count is indicated on the NC panel. The precision of regulation is 0.1 mm. The required positioning of the end rest with a mechanical drive is set by the numerical control unit. The rate of displacement of the end rest is 100 mm/s. The precision of displacement of the end rest is 0.1 mm.

The presses are equipped with a device for semiautomatic positioning of the required impression of a three-impression die under the punch.

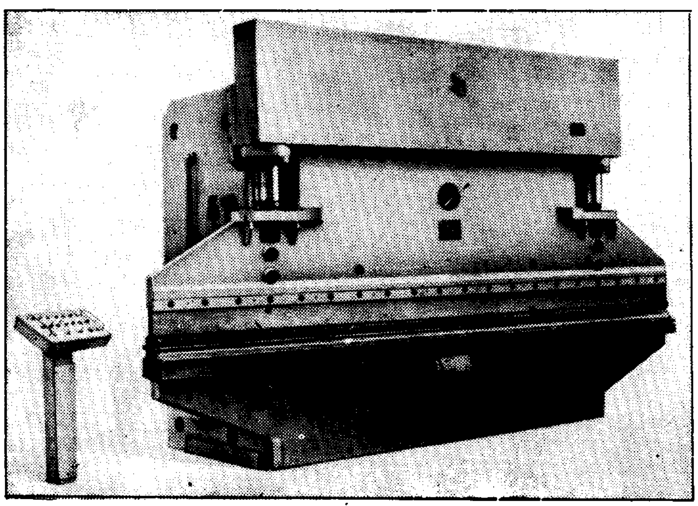
The use of programmed control presses makes it possible to increase labor productivity 1.5-fold, considerably reduce the worker's work load, and save floorspace by excluding intermediate storing of parts.

The presses are employed extensively in machine-, automobile-, ship-, instrument-, and farm machinery building, and other branches of industry.

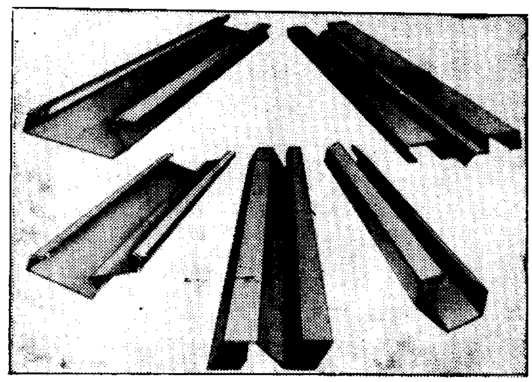
Manufacturer: Azov Production Association for the Manufacture of Forging-and-Pressing Equipment (Azov, Rostov Oblast, Ul. Zavodskaya, 1).

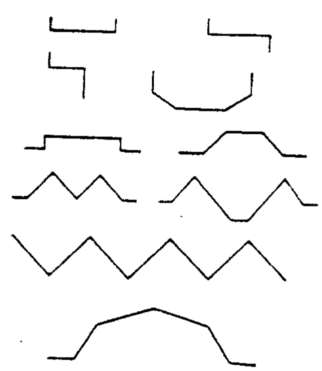
Basic Specifications

	IA1430AP	IA1432P	IA14321P	I1436AP	J1436AP	I1438AP
Nominal force, kN	1,000	1,600	1,600	2,500	4,000	6,300
Table and ram length, mm	4,050	3,400	5,050	5,050	6,400	8,000
Maximum travel of ram, including adjustment, mm	285	285	285	360	320	320
Ram speed, mm/s:						
Idle stroke	80	60	60	40	100	100
Working stroke	21	15	15	17	12	8
Return stroke	100	80	80	80	60	60
Dimension of flanges bent along end rest, mm:						
Minimum	0	0	0	0	75	75
Maximum	1,000	1,000	1,000	750	1,200	1,200
Power of main drive, kW	15	18.5	18.5	30	37	45
Dimensions, mm:						
Left to right	4,160	3,500	5,125	5,150	6,500	8,100
Front to rear	1,715	1,770	1,770	1,990	2,230	2,330
Height	2,980	3,310	3,310	4,620	4,560	5,210
Height above floor level, mm	2,980	3,250	3,250	3,780	3,760	3,910
Weight, kg	9,080	13,450	14,800	28,800	41,670	71,000



Model IA1432AP Hydraulic Sheet Bending Press With Programmed Control





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CSO: 1823/61

UDC 621.979:621.7-52

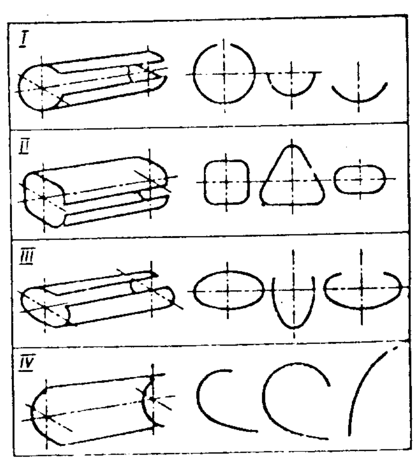
AUTOMATED EQUIPMENT COMPLEX WITH NC MODEL AKI2314P-1

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 5, May 82 pp 5-6

[Article by R.D. Lapsker and V.N. Ignatov]

[Text] ENIKMASh [Experimental Scientific Research Institute of Forging-and-Pressing Machinery], the Azov Special Design Bureau of Forging-and-Pressing Machinery and Automatic Transfer Lines (SKB KO), and the Central Design Bureau for Designing Numerical Control Systems (TsKB SChPU) of the "Leningrad Mechanical Plant" Production Association, have designed and built an automated complex of numerical control equipment, Model AKI2314P-1.

The complex is intended for automated bending of variously shaped parts (see Fig.) from sheet blanks with maximum cross section 2.5X2,000 mm according to a given program, specifically: parts with a constant radius of curvature (Type I); parts with sections having different radii of curvature, joined by plane sections between them (Type II); parts with variable radii of curvature without plane sections (the radius of curvature within each curved section is constant, Type III); parts with the radius of curvature varying continuously according to a given law along the length of the evolute (Type IV).



The automated NC complex includes a Model I2314P NC twin-roller sheet-bending machine; a Model MVLZ sheet stacker with a table and a magnetic handler; a Model MPL4 sheet feeder; and a Model 2M22 numerical control unit.

The sheet-bending machine is designed to bend workpieces according to a specified program. Bending is achieved by embedding (pressing) the smaller diameter upper rigid roller with the blank into an elastic coating covering the surface of the larger lower roller. The bending radius depends on the extent of embedding. The elastic coating is made of grade SKU-7L polyurethane, which possesses high wear resistance.

Two coordinates are programed: the displacement of the blank and the extent of embedding of the rigid roller into the elastic coating, which determines the bending radius.

The coordinates can be controlled sequentially (position control) or simultaneously (contour control).

The machine is equipped with a back stop on which the blank is initially mounted, a mechanism for supporting cylindrical workpieces during the bending process, a mechanism for pushing the finished parts onto a turntable which deposits them on a belt or roller conveyer or other transport device.

The sheet stacker with the table and magnetic handler is intended for feeding sheets one by one from the stack on the sheet stacker table to the sheet feeder table. The magnetic handler separates the leading edges of the sheet blanks when the top sheet is lifted to prevent feeding two sheets simultaneously.

The sheet feeder is designed to feed the sheet blanks into the rollers up to the end stop. The sheet placed by the sheet stacker on the feeder table is oriented so that its leading edge is parallel to the roller axes; this is done by means of side bars with rollers. A carriage with grips then feeds the sheet to the bending-machine rollers.

The Model 2M22 numerical control unit is designed to control the machine drives during bending.

The control functions are provided by processing a data array--a program stored in a microcomputer which performs arithmetical and logical operations and controls the peripheral units via a communication channel. The system is of the contour type. The program parameters are calculated analytically according to the drawing of the part. The functional software and program control is inputted by the NC's photo reader. The dimension values are given either in absolute terms or increments. Interpolation is linear. The program has an updating feature with a total of 99 possible updates.

There are two operating modes of the complex: setting-up and automatic. In the setting-up mode the mechanisms of the complex are operated by push-buttons from a control console. In the automatic mode all the mechanisms operate automatically in the following sequence.

The operator at the main console sets the switch at the automatic mode and presses the "Start" button.

The sheet stacker crosspiece lowers onto the stack of sheet blanks, grips the top sheet with ejector-type suction cups and returns to its initial position. The sheet stacker arm turns through 50 degrees towards the feeder table while the crosspiece at the same time turns through the same angle in the opposite direction. The crosspiece is lowered and places the sheet on the feeder table, after which the crosspiece and the arm return to their initial positions.

The sheet orientation mechanism is actuated. The bars close in and orient the sheet. The carriage with the grips approaches the trailing edge of the sheet, grips the sheet and feeds it to the rollers up to the end rest.

The NC unit is actuated and gives the command for the lower roller of the machine to lift to a given elevation so that the sheet is gripped by the rollers. After that the end rest folds back, opening the way for the displacement of the sheet, while at the same time the grips of the carriage release the sheet and the carriage returns to its initial position.

Bending the workpiece according to the given program commences.

When the workpiece is completed, the lower roller and folding rest of the upper roller are lowered, the top of the receiver table turns to a horizontal position and the pusher mechanism pushes the workpiece onto it. The pusher returns to its initial position, the top of the receiver table returns to its vertical (initial) position, ejecting the workpiece onto the belt or roller conveyer or another receiver unit. The folding rest of the upper roller of the machine ascends to its initial position. The complex is ready to repeat the operation cycle.

The NC equipment complex can be used efficiently at plants with small series, series, and mass production of items in all branches of industry.

The economic effect of the introduction of the complex in industry will be 50,000 to 100,000 rubles, thanks to a a 1.5- to 2-fold increase in productivity and greater precision of manufactured parts.

Technical Data

Maximum dimensions of bent sheet (σ_S = 250 MN/m), mm:	
Thickness	2.5
Width	2,000
Length	4,000
Least length of bent sheet, mm	1,000
Least bending radius, mm	175
Maximum bending speed, mm/min	12
Accuracy of embedding of upper roller with blank into elastic coating, mm	± 0.05
Accuracy of displacement of blank, mm	± 0.5

Maximum height of stack of sheets on sheet stacker table, mm.....80
Rate of feed of sheet by feeder, m/min........................6-60
Dimensions, mm:
- Horizontal..................................7,500X5,900
- Height at floor level...............................2,600

Weight, t..15

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CSO: 1823/60

END